Introduction and Motivation

Meteoroids are one of the most fascinating sources of infrasound. As they propagate through the atmosphere, meteoroids produce a hypersonic shock similar to that of a supersonic aircraft, which may be detected at the ground in the form of infrasound.

In this study we are utilizing a large and unique database of well constrained bright meteor events, detected simultaneously by the Southern Ontario Meteor Network (SOMN) and the Elginfield Infrasound Array (ELIFO) (Fig 1), in order to establish the character of the cylindrical line source blast in the strong and weak shock regime and understand what we can learn about the physical properties of the explosive sources in the atmosphere (hypersonic and supersonic projectiles) and validate shock production models [1].

Methodology

The Elginfield Infrasound Array, hosted by Western University, Ontario, Canada (Fig 2), has been continuously monitoring for meteor generated infrasound, providing the means of establishing a large, one-of-a-kind database of nearly 80 well constrained events. High fidelity automatic measurements (Fig 3) of optically detected meteoroids provide quantities essential for infrasound signal detection, classification and source height modelling (Fig 4).

To search for possible signals, we use the Progressive Multi-Channel Correlation (PMCC) [2] and MatSei 1.7 [3], while comprehensive signal measurements are performed using methodology outlined in [4]. The next step in the process (Fig 5) is to perform raytracing [5] using astrometric data, employing a realistic atmospheric profile, in order to determine where along the optical meteor trail the infrasound signal originates.

Initial Results

• The full signal investigation, analysis and measurements for the regional events using Matlab (Fig 6) and PMCC have been completed.
• Infrasonic waveforms (apparent shape versus time) of meteors show distinct characteristics, leading to a taxonomic classification (Table 1), never previously done.
• Even though all simultaneously detected meteors in this study are direct arrivals and within <200 km from the array, the initial raytracing results indicate that fine scale atmospheric perturbations may play a more significant role than previously thought in near-field signal propagation (Fig 7).
• Further analysis and gravity wave implementation are underway to investigate and validate the aforementioned.

Future Work

• The study outlined here serves as a primer for producing a validated, complete theory of hypersonic shock production at high altitudes, using meteors as the means to validate the model.
• Upon finalizing raytracing for each signal, we expect to have good results on an at least altitude of fragmentation or source emission, size of meteor at time of emission and meteor trajectory.
• The next step in the process is to refine the weak shock theory [1], investigate the near-field shock dynamics and validate the cylindrical line source blast theory.

References


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Contact

Elisabeth A. Silber
E-mail: esilber@uwo.ca  E-mail: esilber/research@gmail.com